OPERATIONS EXCELLENCE AT TRAIL OPERATIONS
A REVIEW OF INTEGRATED PROCESS MANAGEMENT 10 YEARS LATER

by

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Abstract

The purpose of this paper is to analyze the current state of Integrated Process Management (IPM) at Teck Resources Trail Operations and recommend actions to re-implement IPM. IPM was implemented in 2001 to manage Trail Operation's many complex and interdependent processes. Ten years later these production improvements have been lost and the IPM system is now considered ineffective by operations staff. Key issues include lack of training and education, a failed computer system, and high employee turnover. The opportunity cost in lost revenue over this time has been approximately $29.7 million dollars. The behaviours, systems and vision originally implemented in 2001 need to be resurrected and re-implemented in 2011 to achieve operations excellence for today and the future. The recommended implementation strategy includes a new computer system, education and training for all employees, development of a formal continuous improvement process, and re-implementation of IPM daily systems. Lastly, the paper will address the change management issues necessary for helping ensure that Trail Operations will accept and adopt the recommendations made in this paper.

Dedication

To my wife and sons. Thank you for your patience and love.

Acknowledgements

I would like to thank SFU and Teck for providing the opportunity to be a part of the program and Dr. Ian McCarthy and Greg Belland for their support and guidance. I would also like to thank my colleagues at Trail Operations for their time and support while completing this project. Lastly, I would like to thank Kristen for her proofreading expertise and patience in learning more than she ever wanted to know about IPM!

Table of Contents

List of Figures

List of Tables

1: Introduction

The purpose of this paper is to analyze the current state of Integrated Process Management (IPM) in Trail Operations and recommend actions to re-implement IPM. IPM was implemented in 2001 as a process management methodology to manage Trail Operation's many complex and interdependent processes. As a result of the implementation, significant production improvements were attained within two years of its implementation. These improvements were attributed to how IPM decreased process variability. By decreasing process variability, production increased, quality improved and operating costs declined.

Ten years later, the majority of the operating plants are no longer using IPM to manage the processes. In addition, due to high staff turnover and a failed IPM computer system, many of the production improvements achieved during the IPM implementation in 2001 have been lost. This has resulted in Trail Operations over the past five years not meeting its production plan targets and the opportunity cost in revenue over this time has been approximately $29.7 million dollars.

In order to re-implement IPM, several factors would need to be addressed including lack of training and education, a failed computer system, and high employee turnover. The paper will recommend how to re-implement IPM and address key change management requirements to achieve long-term operations excellence.

The paper is divided into six chapters:

- The purpose of the second chapter is to provide background on Trail Operations in order to provide the basis for future arguments for change on organizational structure and process requirements.
- The purpose of the third chapter is to describe in detail what IPM is and why Trail Operations is no longer using IPM effectively. In particular, it will describe how IPM was implemented 10 years ago and compare it to today's utilization.

- The purpose of the fourth chapter is to demonstrate that the cost of poor process management has been significant over the past five years and is the largest driver for change.
- The purpose of the fifth chapter is to provide a summary of what actions need to change in order to properly utilize IPM and then the subsequent implementation strategy to initiate these changes.
- The purpose of the sixth chapter is to outline what is required for successful long-term change management during the re-implementation of IPM.

2: Trail Operations Background

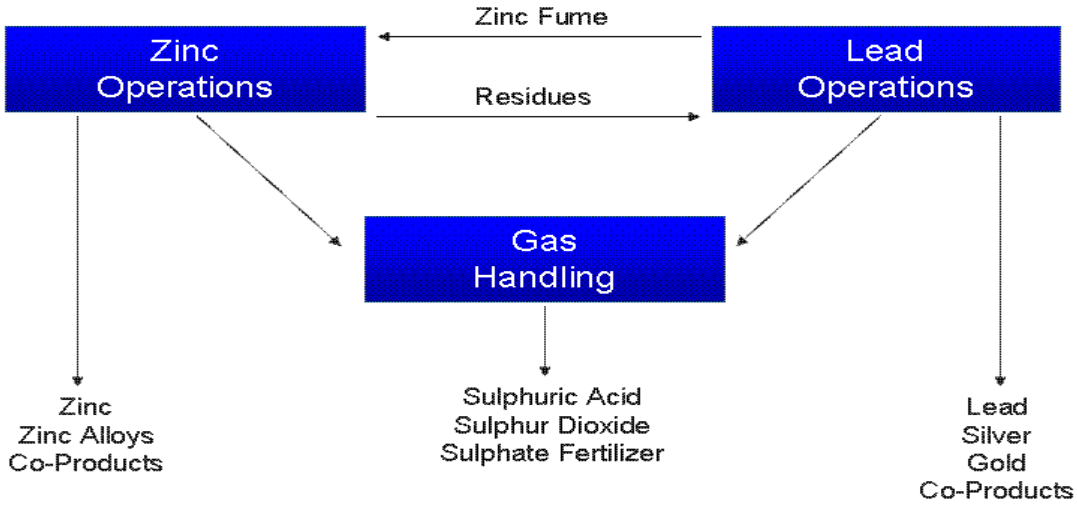
The purpose of this section is to provide background on Trail Operations in order to provide the basis for future arguments for change on organizational structure and process requirements. Due to the integrated nature of its business units, effective process management is required to ensure process stability. Process upsets in one business unit have the potential of impacting several business units, which can then cause significant production and revenue losses. An outline of Trail's organizational chart will provide context for future discussions on whom within the organization is involved with improving IPM as well as to provide context on the extent of employee turnover has had on each level of the organization.

2.1 General Overview

Trail Operations started in 1896 as a copper and gold smelter. Today, Trail Operations is one of the largest integrated lead-zinc smelters in the world. Trail Operations has approximately 1500 employees and has 19 distinct production processes. Plant and equipment is valued at $850 million dollars and it produces over 18 metal and chemical products. [i]

As shown in Figure 1, zinc and lead operations work together to produce several final products including zinc, lead, gold, silver, and other co-products. Both zinc and lead operations feed the gas handling circuit to produce sulphuric acid, sulphur dioxide, and sulphate fertilizer.

Figure 1: Trail Operations Overview Flowsheet[ii]

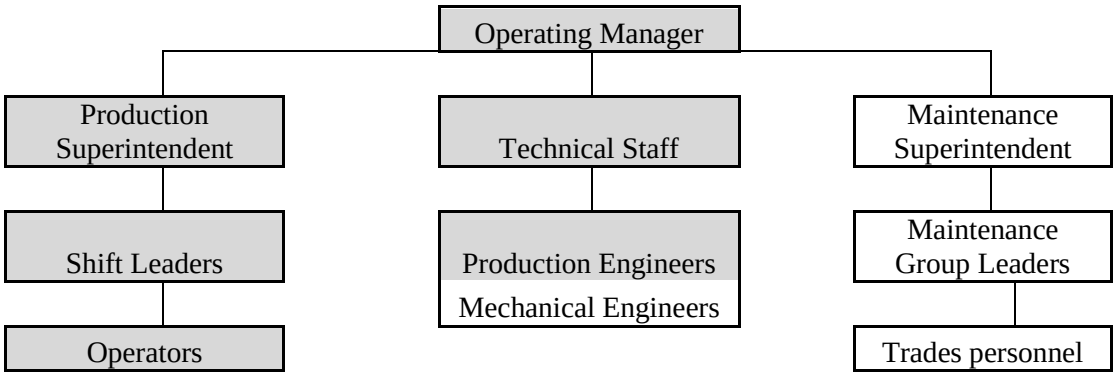


The 19 distinct processes are divided between zinc and lead operations. Zinc operations include three main processing plants: Roaster and Sulphur Products, Leaching, and Electrolytic and Melting. Lead operations include two main processing plants: Lead Smelter and Lead Refinery. Each main processing plant is considered a business unit. Lead and zinc operations are integrated primarily through the Leaching and Lead Smelter business units. Residues from the Leaching plant are used as feed to the Lead Smelter and metal fume from the Lead Smelter is recycled back to the Leaching plant. Off gas from the Lead Smelter is also sent to the Roaster and Sulphur business unit for cleaning and recovery. Each processing plant is divided into smaller distinct processes that have interconnections within the zinc and lead business units. Due to the integrated process, a process upset or instability will impact the operation of another plant upstream or downstream. As a result, maintaining a consistent and stable process is key to Trail Operations.

2.2 Organizational Structure

Each business unit has the same structural outline as shown in Figure 2 and is managed by an Operating Manager.

Figure 2: Business Unit Management Structure



The Operating Manager is responsible for the operation of the business unit including: safety, environment, operations, maintenance, technical, and cost management. The positions highlighted in grey are the personnel primarily involved and have responsibilities with respect to Integrated Process Management (IPM). Other personnel are involved as required.

There are five Operating Managers at Trail Operations and they report to the Production Manager. The Production Manager reports to the General Manager. Also reporting to the Production Manager is the Chief Metallurgist and Management Systems Group Superintendent. The Services Organizations including maintenance and technical services report to separate Senior Managers whom report to the General Manager.

Trail Operations organizational structure is set-up to support the integrated nature of its many processes. As a result, process management is a fundamental aspect to each role highlighted to ensure the steady operation of the plants. Each level of the organization has specific IPM responsibilities from the original implementation. These responsibilities will be discussed in detail. This paper will also provide a recommendation on changes to responsibilities within the organizational structure to support long-term IPM usage and conformance.

3: IPM in Trail Operations

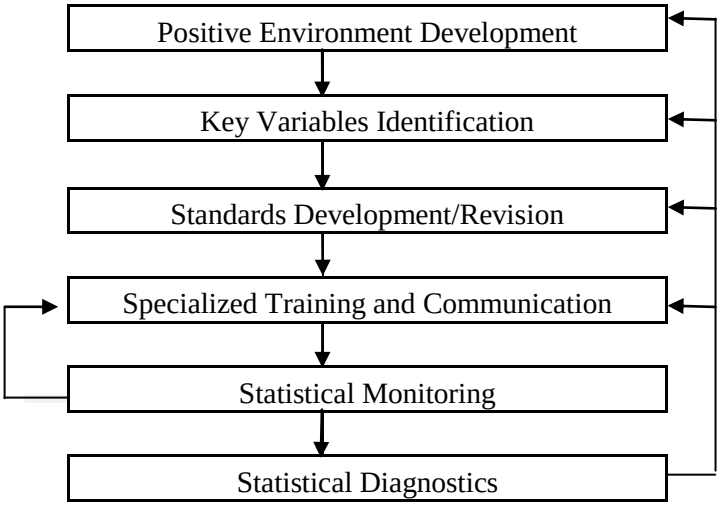
This section will describe in detail what IPM is and why Trail Operations is no longer using IPM effectively. It will describe how IPM was implemented 10 years ago and compare it to today's utilization. In particular, from the results of an informal survey, I will demonstrate the gaps in IPM management as an overall system and its current application in each of the business areas. This section will describe how the failed IPM computer system impacts how IPM is utilized today and limits opportunities for future improvements. Lastly, Trail Operations current high employee turnover exposes a weakness in employee knowledge that is predicted to continue.

3.1 IPM Overview

An article from a Teck (then Cominco) Engineer, John Higginson, in 1993 to the Canadian Institute of Mining[iii] summarized the history of IPM as follows, "In the early 1980s steel industries around the world were in trouble. Out of necessity was born a simple system bringing together the ideas of the quality experts in a down-to-earth "how to do it" format. First called Integrated Process Control, the central idea was to combine statistical process control with compliance to process standards developed by the work force… These ideas were developed and improved culminating with the publication of Integrated Process Management by Roger Slater in 1991. Slater says that, "IPM provides the framework, or skeleton, which brings together the myriad random activities involved in SPC (Statistical Process Control)… and many other modern management techniques, into a mutually supportive role…".[iv] Appendix C summarizes the comparison of quality experts and the approaches emphasized by Roger Slater from Teck's past training material. A key part of IPM is to focus on key process inputs and standards and having a six step closed loop process.[v]

The six steps of IPM can be summarized as follows:[vi]

Figure 3: Six Steps of IPM



- *Step 1* - Creating a positive environment is the first and most critical step to achieving effective IPM. This includes "a visible and dramatic change in the workplace". Focus is also on education and training for the management group and awareness sessions for the entire workforce.[vii]
- *Step 2* - Identify Key Output Variables (KOVs) and related Key Input Variables (KIVs) through a brainstorming session of customers desired product attributes. The team completing the brainstorming include operators, management and engineering staff.[viii]
- *Step 3* - Review and develop Product Control Standards (PCS) that summarize specific information based on a detailed criteria for each KIV and KOV. Focus on worker input and common sense.[ix]
- *Step 4* - Complete training sessions on the material produced in Step 3 and update as required. Also, introduce basic statistical control concepts and expectations. Continue to focus on worker engagement.[x]
- *Step 5* - Statistical monitoring initiated on all KIVs and KOVs and results communicated to all workers. [xi]
- *Step 6* - Complete statistical diagnostics to validate parameters established for KIV and KOV targets. Initiate projects as required to address non-conformance and improve process capabilities.[xii]

To summarize the above steps, the first part is to create a positive environment for change followed by identifying the variables to be controlled. Then develop procedures and parameters using a participative process, and initiate training on the new procedures and implement statistical monitoring of the parameters. Lastly, complete a statistical review of the data to determine opportunities for improvement.[xiii] Continued repetition of the steps allows for IPM to continue to be successful.

3.2 IPM Original Implementation

The first generation of IPM was implemented in Trail Operations was in 1992.[xiv] Trail Operations was struggling to survive and implementing IPM was a part of Trail's plan to improve overall performance. Roger Watson, then Trail's General Manager and Vice President, made it a condition of employment to follow the IPM methodologies and implement it across Trail Operation's operating plants.[xv] It was first implemented in the Zinc plants with the objective to improve the data information system and develop process control standards together.[xvi]

Starting in 1997, Trail undertook a review of current operating practices and in particular, technologies that were available to support ongoing IPM development. From this review, Trail engaged Dawn International to implement the 2nd generation of IPM at Trail Operations from 2001-2003. Dawn's objective was to implement steps 1 through 6 in each of the business units. Each business unit put together a team consisting of operators and technical personnel to work through each of the steps. Step 1 initiatives were identified and implemented, and then the team developed all of the key input and output variables with standards completing steps 2-4. The focus of the implementation was on engagement of the workforce to ensure proper buy-in of operating parameters. Once those aspects were complete, the project then moved into implementing Steps 5 and 6 in the plants. As a part of the implementation, general process management training was provided to all employees based on Roger Slater's Integrated Process Management book and methodology. Every staff person who was a part of the IPM implementation was expected to read the IPM textbook and workbooks to further understand the background of the process being implemented. Roles and responsibilities for each aspect of IPM were established and it was expected that each business unit follow the structured IPM reviews. Daily and weekly IPM reviews were established to review plant performance and every 6 months, a statistical analysis of KOVs was completed to provide a basis to initiate step 6 projects.[xvii]

The implementation also included the installation of software that facilitated the use of IPM methodologies. In particular, amongst the many tools included, the software allowed for the following:

- Facilitated the use of control charts around key input and output variables.
- Required operators to annotate out of conformance parameters that would roll into a pareto analysis of most frequent issues and reactions.
- Development of visual relationship trees key input and output variables.
- Included the development of procedures, Process Control Standards (PCS), that were attached to each parameter. Each PCS documented the parameters the variable was to be managed within and provide direction on how to react to out of conformance situations.

The software was supported on an annual basis by Dawn International for any development and ongoing maintenance requirements.

The results of the 2nd generation of IPM implementation were positive.[xviii] Total implementation costs were approximately $1.6 million and within 2 years of the initial implementation, $700,000 of direct, measureable savings were achieved. Conformance to key input and output variables also increased significantly in the first 2 years.[xix] This increase in conformance would also have several other indirect benefits that were not quantified.

3.3 2011 Status – 10 years later

IPM was implemented in all business units by 2003. Following its implementation in the last business unit, an IPM coordinator was assigned the task of ongoing development of IPM in each of the business units. The coordinator's role was to facilitate and coach personnel at all levels of the organization and help develop Step 6 – the continuous improvement process. In 2007, the IPM coordinator role was no longer specifically required and the responsibilities were absorbed within the operations group.

In order to get an assessment of the state of IPM in Trail Operations, I completed an informal survey of 31 people within Operations. A majority of the interviews, 27, were primarily operations staff from all levels of the organization including: Production Manager, Chief Metallurgist, all Business Area Managers, Production Superintendents, Shift Leaders and Production Engineers. These staff interviews represented approximately 46% of the operating

staff that have IPM related responsibilities. I also interviewed four operators to round out the feedback on IPM utilization on a floor level. The focus of the survey was to determine whether we are still practicing IPM as per its initial implementation and have we developed a continuous improvement culture. Specific questions included:

- Are we following the IPM roles and responsibilities document?
- Have we effectively implemented the structured reviews to manage the process daily as well as initiate long-term opportunity projects?
- In particular, are we using the IPM statistical analysis to develop opportunity improvement projects for the future? Essentially, are we doing Step 6?
- Has everyone bought in?

The following table summarizes the results of the survey.

Table 1: Summary of IPM General Survey - Completed February 7th to February 18th, 2011

Question	Results
Are you aware of the IPM controlled document and your responsibilities within it?	93% of staff responded no – they were not aware of the document and the expectations with it.
If IPM failed, does it matter?	68% stated no. They currently use other methods to help manage the process.
Is IPM used effectively?	Yes = 16%, Moderately = 34%, No = 50%
Is your understanding of roles/responsibilities within IPM clear?	57% said no.
Are you KIV or KOV focused?	65% stated KOV focused.
Are we doing Step 6 – continuous improvement?	100% stated no.
How much process management training have you received over the last five years?	97% said zero hours.
Evaluation of crew knowledge of IPM?	Strong = 10%, Variable = 52%, Weak = 38%

The survey results indicate that Trail Operations has lost most of the gains made during its implementation. In general, the feedback between staff and operators was consistent. Of management staff responsible for using IPM, 93% were not aware of the document outlining

roles and responsibilities managing IPM. Although most felt they were probably following the document expectations, the subsequent questions reveal that they were not. A good example is that over half the respondents did not feel their roles and responsibilities within IPM were clear. 68% people stated that it did not matter if the IPM computer system failed. Many of the people interviewed had found more efficient means of managing the process. Of the people interviewed, 100% felt there was no structured process to initiate improvement projects. Most improvement projects were based on offline analysis of different individual's ideas. Operator use and understanding of IPM was not strong. Many comments indicated that operators do not use IPM to manage the process, but simply fill in the information for conformance. In fact, most did not believe we are using the information effectively in particular the annotations entered by operators.

Of particular interest, 97% of those interviewed have not received any follow-up training in the past five years. In addition, 90% of those interviewed did not feel that operator's process knowledge was very strong. It was commented several times that those who are considered strong in process management are on the verge of retirement. In particular, production engineers hired in the last few years had no training and did not understand their expectations.

During the implementation, one of the items focused on was a consistent approach to managing the processes across Trail Operations. However, over time, other computer systems used to manage plant equipment have evolved beyond what was available during the initial implementation in 2001. The tools provided in these more evolved systems provide an easier way to manage the process. What has been lost, however, regardless of where the data comes from, is a basic understanding of process management and how to achieve continuous improvement. This is confirmed from the survey where there has been no training provided over the past five years on IPM.

The following table highlights the state of IPM performance by plant in 2007.

Table 2: 2007 June Monthly Conformance/Capability Report[xx]

Plant	KIV's	Conformance?	Capable?	On Aim?
Roasters	7	29%	0%	33%
Sulphur Gas	37	40%	41%	59%
ZPL	14	14%	21%	21%
Crystal Plant	18	5%	19%	50%
Granular Plant	11	21%	7%	45%
Sulphide	42	31%	21%	29%
Cadmium	8	75%	50%	38%
Oxide	15	44%	22%	67%
IGP	10	20%	20%	50%
Electrolytic	27	45%	14%	56%
Melting	35	46%	29%	37%
Feed Plant	27	46%	35%	63%
KIVCET	31	6%	6%	45%
Pb Drossing	22	18%	14%	45%
Pb Ref	11	82%	27%	55%
Ag Ref	5	11%	11%	20%
CPP	3	0%	0%	67%
ETP	8	25%	25%	63%
Alloy Plt	3	100%	100%	67%
TOTALS	**334**	**33.1%**	**23.1%**	**46.8%**

The table shows that in 2007, there was significant opportunity for improvement in process management. Only 23% of Trail processes were capable and 47% were in conformance. Since 2007, it could be argued that the above analysis would be worse especially since our use and understanding of IPM has decreased. Considering many of the plants no longer use IPM, completing a similar analysis would not add further value. The survey indicated that our current process management practice is to focus on short term trending with operators and engineers completing offline analysis based on their own analysis tools. As a result, process management is not transparent and tends to rely on the abilities of an individual and not a specific system. This creates an issue with employee turnover as knowledge transfer is difficult under these circumstances.

3.4 Computer System

One of the advantages of the IPM rollout in 2001 was its computer system. There were no other computer systems similar to it at Trail Operations that provided the transparency for key operating variables for each plant. Through the implementation, time and resources were applied to build process sheets that each business area would use to manage their process. Operators and staff were expected to use the computer system to help manage the process and ensure the system was continually upgraded to reflect improved control and knowledge. Audits were completed to ensure information was properly entered into the system and the subsequent analysis was completed.

As of 2007, the IPM software is no longer being supported Dawn International.[xxi] As a result, there have been limited improvements to the software in comparison to the process control upgrades in each of the plants. In particular, the installation of Foxboro, Wonderware and ABB control systems in each of the business units have provided engineers and operators increased data capture and simple trending options. The IPM software has become more difficult to use in comparison to the evolution of other systems in Trail Operations and any changes to the system must be developed internally by Information Technology (IT) personnel within Trail Operations.[xxii] Lastly, the most significant issue to the integrity of the IPM software is that Microsoft security updates replace a software component in IPM that causes application errors. This has resulted in periods during which the IPM software was not working and also puts the entire system at risk of permanent failure.[xxiii] Trail Operations does not own the source code for the software so the risk of failure increases each passing year.

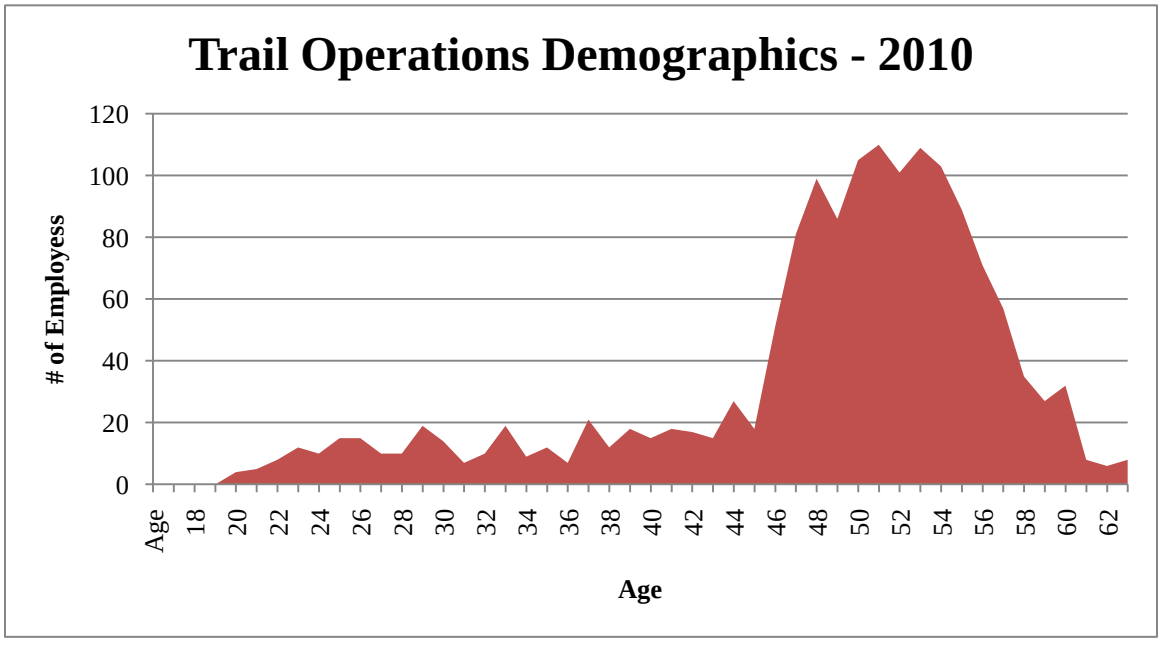
As previously stated in the paper, many of those surveyed have alternative means of reviewing the process without using IPM. Several of the key issues of the IPM computer system from those surveyed include: information in real time and higher resolution (i.e. current resolution every hour) and most significantly, the information does not include the other tools used by the business areas to manage the process. Statistical tools used by Production Engineers are not a part of the IPM computer system and as such, analysis is completed offline most often not using any of the information entered into IPM. Ultimately, in order to support IPM for the future, these issues need to resolved.

3.5 Influence of Employee Turnover

In this section, I will explore how Trail's current high employee turnover is a part of Trail's problem with IPM. I will also show that the ongoing status quo will not improve in terms of process management as a result of future employee turnover projections.

Since the early 1990s, Trail Operations has reduced its manpower from 5000 people to approximately 1500 people today. This has been achieved through divesting of downstream processes and businesses as well as through technological improvements and increased plant efficiencies. The manpower reduction has been achieved while also increasing lead and zinc production over the past 20 years as well. However, one drawback of the manpower reduction is it has created limited employee turnover as employees originally laid off were eventually rehired to fill job vacancies. As Figure 4 demonstrates, this has resulted in an average employee age of approximately 49.2 years old and a significant number of Trail Operations employees being close to retirement. In fact, the average age has actually decreased from previous years where the average age peaked at 51 years old. This reflects that significant employee turnover has begun.

Figure 4: Trail Operations 2010 Demographic Summary[xxiv]



Over the past five years, 285 people have retired from Trail Operations.[xxv] HR modelling predicts another 543 retirements in the next five years.[xxvi] Assuming an average of 1500 total employees are Trail Operations, over 55% of Trail workforce will have retired between 2006-2015.

The majority of the retiring workforce has over 30 years experience. Table 3 highlights the operating plants with the highest turnover from only retirements in the past five years. Of note, plant turnover can also occur through operator transfers where an operator can move to another plant that has an opening (a retirement would be an example of an opening). Sickness, long-term injury and quitting are other turnover reasons. Operator transfers typically impact a few specific plants due to the nature of the work (i.e. heavy manual labour). None of the plants below have seen a high level of transfers.

Table 3: Plant Specific Retirement Summary 2006-2010[xxvii]

Plant	# of Retirements in Last 5 Years	Total Operators in Plant	% Employee Turnover (Retirements Only)
Sulphide Leaching Plant	7	32	22%
Zinc Electrolytic Plant	23	62	37%
Zinc Melting Plant	18	68	26%
Zinc Roasters	8	39	21%

The loss of long-term employees is problematic when it happens at the same time. Each plant is structured such that the highest seniority employees work in the jobs that have the most responsibility for plant performance. For example, in the Zinc Electrolytic Plant, they have lost their entire top tier of operators and reliefs over the past five years. With the rapid turnover, new employees only five years into the plant will be relieving for the top tier operator position and they will be responsible for core aspects of the operation. Previously, these positions had been occupied by operators with over 30 years experience.

In particular, the challenge becomes ensuring the operators have the necessary process management knowledge to be effective. Each operating plant has a list of key procedures that cover the basic aspects of each role. There are specific training requirements for each role to ensure the procedures have been reviewed, understood, and demonstrated. However, training still relies on effective transfer of knowledge from operator to operator to fully understand all aspects of a position. This has the potential of creating issues when the process is out of conformance and the new operators are required to take more time to address the root cause of the issue.

Operations staff has also undergone significant turnover in the last five years. Table 4 summarizes the number of staff changes in each of the business areas specific to operations roles.

Table 4: Operations Staff Turnover 2006-2010[xxviii]

Role	Total Staff Changes/Position					Total Changes	Total # of positions	% turnover
	E&M	LCH	RST	Pb S	Pb N			
Operating Manager	1	3	0	1	1	6	5	120%
Production Superintendent	2	3	2	2	0	9	8	113%
Production Engineer	2	3	2	4	3	14	8	175%
Shift Leaders	2	3	2	3	2	12	30	40%

Other than the shift leader position, every position has seen at least a 100% change in staff personnel. In particular, the production engineer position has seen 175% turnover in the last five years. These are significant changes when you consider the amount of parallel change to operators at the same time. It is difficult for the business units to maintain a consistent focus on the key process aspects of the job when employees are spending a significant portion of time simply learning their role.

The high engineer and production superintendent turnover impacts Trail Operation's ability to effectively use IPM. They have key roles within the IPM process to ensure proper day-to-day management of the process and to initiate improvement projects. If an area was not using IPM effectively, the high turnover will ensure it does not improve. Ultimately, focus on key variables of the operation will be lost. This was confirmed by the IPM survey where 93% of personnel surveyed were not aware of their responsibilities for IPM as per the IPM procedure. In addition, since there has been no process training over the past five years, it is difficult to believe that there would be effective process management in comparison to the IPM implementation 10 years ago. Too much information has been lost and in particular, the structure around the IPM is not being followed. If the crew knowledge of IPM is variable at best across the business areas and over half of the staff do not feel roles and responsibilities are clear in process management, one can safely assume that the process is not being effectively managed 100% of the time.

4: Value of Process Management

This section will demonstrate why the cost of poor process management has been significant over the past five years and why this is the largest driver for change at Trail Operations. The value of process management will be quantified based on Trail's production. The focus will be on Trail's two primary products – lead and zinc in comparison to the production plan for last five years.

Trail Operations sets production targets each year based on plant availability (including planned major shutdowns), concentrate availability, deportments of key elements, and plant operating parameters. Plant operating parameters are a key part of the model as they reflect the plant's current production capabilities and deportment of key elements. The model is able to determine the most profitable production targets based on a specific concentrate mix. The targets become the plan for the year unless business decisions are made to curtail production. A good example of that was in 2008-2009 when zinc production was reduced as a result of the sudden down swing in market conditions. Meeting plan is Trail Operations key focus on maximizing its profitability for the year.

Table 5 summarizes Trail's production of its two key products – zinc and lead versus the production plan over the past five years. Only once during the last five years has Trail operations been able to meet planned production for each of the main products. Of note, the plan numbers for 2008 and 2009 have been adjusted to reflect the production curtailment due to market conditions. In particular, the last three years have been quite difficult missing the production plan by significant margins.

Table 5: Trail Operations Plan versus Actual 2006-2010[xxix]

	2006		2007		2008		2009		2010	
	Plan	**Actual**	**Plan**	**Actual**	**Plan**	**Actual**	**Plan**	**Actual**	**Plan**	**Actual**
Zinc (MT)	295,000	296,065	295,400	291,893	292,400	269,937	245,840	239,905	292,500	278,291
Lead (MT)	98,500	90,294	84,300	76,372	93,500	85,016	84,498	72,570	80,800	71,475

Each of Trail's five business units, due to its integration of processes has seen significant production upsets resulting from the reduced production of lead and zinc. An example would be 2010 zinc production losses. As shown in Table 6, a significant portion of zinc's production loss in 2010 was due to low electrolytic current efficiency and increased cell top maintenance.[xxx] The

table also compares those parameters to equivalent production losses in 2007. In comparison to 2007, there is an increase 11,000MT of lost zinc production due to those two parameters only. The change in production loss between the two parameters accounts for most of the difference between plan and actual for 2010.

Table 6: Zinc Electrolytic Production Loss Comparison (MT/year)[xxxi]

Year	Current Efficiency (MT)	Cell Top Maintenance (MT)	Total Losses (MT)
2007	616	1,328	1,944
2010	9,423	3,781	13,204
Difference	8,806	2,453	11,259

Current efficiency and cell top maintenance performance are a reflection of process management as they are KOV's for the electrolytic plant. Maintaining a high current efficiency and effective cell top maintenance is achieved through maintaining a series of parameters within specifications. Once one of the parameters is out of conformance for an extended period of time, current efficiency will decrease and cell top maintenance requirements will increase. The electrolytic process has over 56,000 electrodes (cathodes/anodes) so if a part of the process is not operating efficiently, then it will take a significant period of time to return the process into control. The key aspect to controlling both KOVs is the KIVs for each are known and are manageable. By maintaining the same process management as in 2007, the zinc electrolytic plant alone would have increased production by 11,000MT as the feed to the plant was available and the zinc melting plant has excess capacity. Assuming $259/MT incremental margin on zinc[xxxii], this translates into a loss of $2.8 million dollars.

The above example from the Zinc Electrolytic plant is only one of several examples in each business area. Although there are many contributing factors to a production upset, poor process management is a key factor to all of the upsets. The survey completed on IPM management highlighted the lack of a process management structure across Trail Operations. This would be a significant contributor to the plant production issues as the understanding of key plant variables are at risk of not being focused on and managed closely. Considering that most of the tools within the IPM system are not being used, half of the operations staff do not believe losing IPM is a significant issue and over half do not feel roles and responsibilities within managing the process of IPM structure are clear, it only raises more questions about the integrity of Trail's process management system.

In saying the above, most plants have implemented other means of managing the process outside of IPM. The second issue previously described which would limit alternative process

management systems is the high turnover of personnel in each of the operating areas. Each business area has seen significant turnover of operations and staff over the past five years. If the business area is not following a structured process management system, then the loss of experience has the potential of impacting its process management system and their ability to achieve production targets. In particular, significant turnover in production staff over a short period of time makes it difficult to appreciate the key variables required to be controlled especially if the systems in place are based on the previous person's experience and ad hoc improvement processes. An argument can be made that this was one of the main contributors to the electrolytic upset. The plant has had significant turnover over the past several years which has impacted their understanding of a few key input variables.

Table 7 summarizes the cumulative production losses over the past five years compared to production plan (adjusted for the change in plan due to market conditions) for lead and zinc. Based on $259/MT zinc incremental margin and $394/MT lead incremental margin, this equates to $29.7 million dollars in lost opportunity over the past five years by just making planned production for the year. The lead and zinc margins are based on the average margins from 2006 to 2010.[xxxiii] Of note, this does not include related losses to co-product revenues such as gold, silver, indium and germanium. Although not all of the production losses can be attributed to poor process management, this represents a huge opportunity to improve Trail's profitability without installing new pieces of equipment as the plants have already demonstrated those production levels historically within their current infrastructure.

Table 7: Sum of Production Losses Compared to Plan 2006-2010[xxxiv]

	Cumulative Loss (MT)	Cumulative Loss ($)
Zinc	45,049	$ 11,667,805
Lead	45,871	$ 18,073,333
Total		$ 29,741,138

The question becomes whether things will improve based on Trail's current retirement profile and process management situation. Retirement modelling indicates that Trail will continue to experience high levels of turnover over the next five years. As a result, the remaining plant experience that is helping manage the process will retire and be replaced by operators and staff whom have significantly less process knowledge. As indicated by the survey, there is not a structured approach to process management across Trail operations. IPM is the system that was previously implemented to support the plants and ensure the plants maintain a high level of focus on key variables. Without that system, the plants continue to rely on people and unfortunately, relearning what key variables are required to manage the process. Considering pending

retirements are inevitable, re-invigorating IPM at Trail Operations is critical to achieving operations excellence.

5: IPM – Moving Forward & Implementing Change

This section of the paper provides a summary of what changes need to happen in order to properly utilize IPM and the subsequent implementation strategy to initiate and maintain these changes. In order to effectively achieve operations excellence, Trail must review its current process management practices and implement changes. The employee survey demonstrated a positive memory of IPM, and there is an opportunity to make lasting behavioural changes by re-implementing IPM. However, in order to take advantage of the opportunity, an effective implementation strategy is required to ensure short-term gains and long-term change.

5.1 Moving Forward

The purpose of this section is to highlight key behaviours and systems that will need to change in order to re-implement IPM. These behaviours and systems would include:

- Refining and optimizing current processes with a focus on IPM methodologies.
- Determining a proper computer system that supports the changes required.
- Focusing on utilization and analysis of data at all levels of the organization.
- Establishing a continuous improvement process.

Several factors support the current implementation of IPM. The first factor is that IPM is favourably perceived by the majority of operators and staff and because the institutional memory is positive, they will be more open to supporting the initiative. The key from an implementation perspective is to ensure that positive memory is leveraged and re-enforced throughout the implementation. The biggest factor is many of the procedures and expectations will not be changing. The implementation will be a re-focus on what we used to do that helped make us successful and ensure we stay on the journey towards successful process management. By articulating the vision along those terms, operations staff in particular will not feel it is just another system but taking what they are already doing in isolation and working as a group to make process management better. Operator buy-in will be contingent on whether the information is being used to improve plant performance. Operators are currently inputting information into IPM, but do not believe it is adding value. By working with operators, the implementation

process will ensure the data entered is actually meaningful in the long term. Also, through a concentrated focus on the six-month KOV reviews and initiating Step 6 projects, operators will see the value of the system. Ultimately, the organization will support the system if it allows the plant to operate more effectively.

The biggest hurdle with IPM is the computer system and staff's understanding of the methodology. Although 68% of staff surveyed did not feel losing the IPM computer system mattered, they commented that was the result of finding more effective means to review the process. The challenge to re-implement IPM is to ensure the computer system selected effectively gathers all the required process data in real time so that it becomes the source of process reviews. If that objective is achieved, then the issue will become how staff uses the information.

Currently, each area has substituted daily IPM reviews with general plant review meetings that include a general review of process information. Every operations staff person has a system in which they use to review the process. Assuming the computer system issues are being managed, then part of the implementation strategy is to develop effective management summary reports on the process KIVs and KOVs, then modify the daily reviews to ensure the process review is occurring. The template for both aspects already exists from the implementation in 2001. Each area currently follows the template in some form. The issue becomes updating the information that rolls-up into the various process review meetings and changing the conversations to focus more around process management. As a result, a review would need to be completed of the current summary reports and upgrading the reports as required. They would be layered in terms of detail so that each level of the organization can review the relevant level of information. The roll-up of information will require an effective review of KIV and KOV relationships, but through that review, Trail will improve their overall understanding of its process and relationships.

Once the management reports are upgraded, then the focus turns to how management uses the information. If the questions asked about plant performance change from throughput related to KIV and KOV conformance and trending, then behaviours will begin to change within each business unit. Part of the behavioural change is to ensure specific items of the process are reviewed daily, weekly and monthly. In particular, focus needs to be on how the data is analyzed so that we are not simply focused on conformance, but on process capability and trending. This should happen at the daily and weekly IPM reviews as well as in the six-month KOV reviews. These reviews will need to be resurrected in all areas and a greater focus placed on challenging

process during those reviews. By setting a high standard in those reviews, rationalization of information will be more difficult if we focus on using statistical methods for improving our KIV and KOV performance.

Lastly, a major change in behaviour is how the IPM data will be used to initiate continuous improvement. Considering all staff were not completing IPM Step 6 as intended and yet felt it was important, highlights an excellent opportunity to change. The key will be to establish discipline to complete proper statistical analysis and initiate continuous improvement projects. Considering most projects are initiated based on experience or a process upset, this will require a significant change in behaviour. Re-starting the six-month KOV review will provide the information required to understand where true improvement opportunities exist. Considering the conformance charts from 2007 shown in the previous section, improving process capabilities has to be the focus for improvement. Considering the information used in the Step 6 process is based from the previous IPM steps, it will re-enforce ongoing focus of the previous five steps.

5.2 Implementation of Changes

This section will recommend the implementation strategy to support the re-implementation of IPM. The changes consist of addressing several factors discussed in the previous chapter:

- Management Priority – Establish that the re-implementation of IPM is a priority for Senior Management.
- Implementation Champion – This is a critical aspect to lead the implementation and the purpose of this section is to provide a framework on what is required from the role.
- Management Expectations – Discuss what behaviours are required by management staff to support and implement IPM.
- Computer System Implementation – Review the key aspects required for any new computer system.
- Training and Education – Establish a scope for what is required to train and educate staff and operators as a part of the "re-implementation" process.
- Re-implementation – Provide a framework for bringing the IPM teams together to initiate process analysis in each business unit.

- Establishing the Continuous Improvement Process - Summarize the actions required to implement the Step 6 continuous improvement process.
- Long-Term Organizational Structure Changes – Provide the strategy to ensure IPM is driven beyond the re-implementation stage of the project.

5.2.1 Management Priority

The first step in the path forward is accepting that IPM is not being used effectively. As stated in Roger Slater's book, when a parameter is out of conformance, "we do not have an opportunity, but a process failure".[xxxv] It has to be recognized by all levels of the organization that effective process management is essential for Trail Operations to be a viable operation today and for the future. This paper already described one process failure in the Electrolytic plant, but each business unit has had at least one process failure that significantly impacted production in the last five years.

When IPM was implemented in 2001, it was one of several programs that would lead to Trail's success for the future. This message was from the General Manager and was communicated directly to every employee in Trail Operations. There was no question that IPM and effective process management was a priority for Trail Operations. Today, we use the terminology in our meetings, but the intent behind the questions has lost its focus. From the IPM survey, the Production Manager, Chief Metallurgist and Operating Manager positions admitted that we are not using IPM as intended. Although each person had different reasons, the answer is still the same. As indicated by the survey, our communication of IPM performance does not occur unless initiated through another process.

We need to stop our current behaviours and create a rallying cry for change. The system implemented in 2001 actually had several positive aspects that most interviewed felt were worthwhile. As a result, the rallying cry would be about re-igniting IPM and it becoming a driver for change and improvement within Trail's systems. Past production performance, employee turnover and the state of IPM itself create the sense of urgency for change and that we can do better. The buy-in to improving our process management systems already exists. The high turnover of employees also provides a unique opportunity to instil the core process management principles to ensure ongoing success. Without change, the process management void will continue to be filled with people's best interests and not provide consistent process management success.

Once it has been established that we have a process management failure and that we can solve the problem, several things need to be implemented to ensure the organization understands that it is a priority. First, the basic principles of process management have to become one of our guiding principles. Trail Operations has several Guiding Principles that "define what we value, how we behave, and what we expect of others".[xxxvi] Process management has to become one of our guiding principles in order for us to have long-term success within Trail Operations. An example of a guiding principle would be, "We are all responsible for quality and our actions strive for continuous process reliability and improvement". This provides a call to action for all processes in Trail including maintenance, safety and the environment.

Our current 10-year plan has Trail focused on two business models – continue being a low cost producer and continue to maximize co-products to generate alternative revenue streams. Effective process management is essential to achieve both of those objectives. As a part of the vision, we need to have a common understanding as to what success will look like in the future and what each of our roles will be. We need to set aggressive targets for Trail Operations in order to be successful for the future. Once that has been communicated and a sense of urgency established, then we will be in a position to rally the organization.

Another major decision point will be whether to continue using the IPM philosophy as the platform for process management. Trail has been using IPM since 1992-1993 in one form or another, and most operators and staff have an understanding of what that means. The good thing is that people know of it, remember it positively and agree that we need to do better at it. To implement a completely new philosophy would require a significant amount more change and may be counter productive to the positive energy that agrees change is needed. A different process management program has the potential of changing the focus from improving the process to implementing just another new program. The fact personnel reflect upon IPM in a positive light is a huge step forward on making a change.

5.2.2 Implementation Champion

The second aspect of re-establishing process management is assigning a champion to lead the re-implementation. The champion or project leader needs to be a respected individual within the organization capable of creating short and long-term change. The person needs to understand Trail's integrated nature in order to effectively develop the plan to re-establish IPM. Most importantly, the person must report directly to either to General Manager or jointly to the General Manager and Production Manager. Otherwise, the rest of the organization will not see the role as

important as the other responsibilities of managing the business unit. Having a clear line of sight to Senior Management will provide the champion the necessary support to overcome roadblocks and access the necessary resources to address issues during the re-implementation.

The champion's scope would be simple – re-establish IPM within Trail's process management system and establish the necessary systems to ensure its long-term viability. Initial actions would include: complete a post mortem on why the previous IPM implementation failed, complete a more detailed survey specifically targeted at operators, and establish a steering committee with representatives from each level of the organization to guide and provide feedback on each aspect of the re-implementation process. These actions will provide the champion with enough background to develop the path forward on achieving their scope of work.

One aspect that will need to be explored further by the champion is whether a consultant will be required to support the re-implementation of IPM through Trail Operations. A consultant will be required to implement the new IPM computer system. The use of a consultant to support implementation will be dependent on whether the champion is available to find a firm that supports IPM management as per Trail's history. Previously, Trail used a company call Dawn International to implement IPM from 2001-2003 with success. They were well regarded by operators and staff at that time. Unfortunately, due to other reasons, the relationship between Teck and Dawn International is such that working together in the future is most likely not viable. As a result, the question of consultant is a question of fit. Since Trail is focused on the "re"-implementation of a process, we are not looking to start something new, but build on what we already have. If there is a consultant that is able to support such an implementation, then the question on the need of a consultant for implementation becomes a question of available resources to implement processes quickly. Considering the value of stabilizing Trail's business units and achieving planned production targets, adding resources to facilitate IPM's implementation is the right decision. Of note, the consultant does not necessarily need a process management background. Depending on the scope of work, if the consultant is focused on implementing the behaviours around IPM management, then their background could be on change management and coaching. Trail is currently using West Wind consultants for similar support on another initiative on the property and they could be considered for this type of application as well.

5.2.3 Expectations of Management

Once the champion has been established, the overall expectations of the organization have to be made clear. In 1992-1993, Roger Watson made expectations clear by stating that IPM was a condition of employment. Things should not be any different today. If our expectations are anything less, then any meaningful change will fail. This would apply to all aspects of implementation. In particular, once roles and responsibilities are established, then each person must ensure they are meeting their commitments to process management. Otherwise, we may see some short-term gains, but entropy will again remove any opportunity for long-term success.

We should expect the organization to meet continuous improvement targets specifically focused not only on final production numbers, but also on each of the KIVs. These expectations will lead to utilizing the Step 6 process for continuous improvement. Trail was able to achieve short-term improvements during the last IPM implementation. However, once those improvements were realized, focus shifted to other aspects of the business. By re-implementing IPM, we will be able to again achieve more short-term goals. The change in philosophy has to be that effective process management is a cornerstone on achieving our objectives every year and that it must always be a priority. In other words, if Trail expects to meet and beat the production plan levels each year, IPM must be a foundation to achieve those objectives.

The other expectation of the organization that must be made clear is IPM is a system that facilitates succession planning. The standards and background information on each key variable are captured and communicated as a part of the IPM process. This will support improved communication of key variables and standards for managing the process. This will help focus the organization on achieving stability and to continually look at improving performance based on a common baseline. Considering high turnover is an issue across all levels of the organization, it provides a common starting point for everyone. New and experienced operators will have the same perspective on the type of information that should be captured and managed. Engineers and operations staff will have the same experience on wanting to ensure systems are in place so that they are not spending their time on known issues. This issue alone will provide the momentum for lasting system change.

5.2.4 Computer System Implementation

Once a champion has been established and the expectations of the organization have been made clear, then the next phase will be to upgrade the current IPM computer system. One of the key statements made during the IPM interviews was that the current computer system did not

provide the necessary functionality for employees to effectively do their jobs. As a result, the system has become to many a focal point that IPM is not important. Considering most of Trail's systems have had upgrades in the past 10 years, IPM has not changed. Secondly, the system reliability only is getting worse. As a result, employees and staff will need to know that a part of re-implementing IPM is to improve the data management system. This will help the organization understand that change will be happening and provide an opportunity to solicit feedback for potential improvements.

In order to complete the review, the champion must lead a review of what our expectations should be of the computer system for all levels and functions within the organization. The expectations would be defined from a more detailed survey of all levels of the organization; in particular, getting more detailed feedback from operators and engineers. Once the list of expectations has been developed, a decision analysis will need to be completed in order to prioritize the list into a decision matrix. The champion would engage the steering committee during the review process. Since the steering committee would have representatives from the key organizations, they would be an effective group to properly complete the decision analysis.

In parallel, there should be a review of the computer systems currently being used in industry that would be compatible with our current IT systems. This information will be required once the system priorities are established from the steering committee. Although there probably is not an easy answer in terms of a computer system that has all the functions required, each system will have its own strengths and weaknesses. A clear understanding of what those are for each system will allow for a decision on how to move forward on choosing the right computer system.

The new computer system will need the ability to capture all the information into one location and properly capture batch processes. The current system is designed for continuous processes, however, it is not able to effectively capture and analyze data from batch processes. As a result, plants that are primarily a batch process do not effectively use IPM and have implemented their own systems without effective use of the overall methodology. In addition, when most of the interviewees were asked about potential improvements to the IPM computer system, the majority commented on having all the data reside in one location instead of having to navigate through multiple systems as they currently have to do. If that were made possible, it would make it easier for operations and engineering to effectively monitor all the data available for the process.

5.2.5 Training and Education

Process management training needs to be completed for all levels of the organizations. IPM implementation from 2001 had several different aspects to the training. The same training will need to be repeated in similar form as a part of the implementation process. Due to the high turnover at all levels of the organization, it is critical that everyone have a clear understanding of how effective process management is accomplished through IPM. More importantly, the training has to establish the common language for the organization to view process management. The original implementation training included: Senior Management, Staff and then all of the operators within a plant. Once the base training had been completed, then a team from a business unit would be trained in greater detail in order to start developing IPM standards. One of the decisions the champion will need to determine is how much training is required for the organization. This will have to be based on how much the IPM system will change and to what degree will the current KIVs and KOVs in a business be reviewed and updated.

A second aspect to training is to facilitate effective interpretation of process data on a daily, weekly and monthly basis. A potential gap in the original implementation in 2001 was to spend more time with the organizational staff on how to properly use the data and translate that information to effective reviews with operators and other staff. In particular, Business Unit staff from the Operating Manager to the Shift Leader will need coaching on how to become process leaders following the training. In order to change our behaviours, staff will need to appropriately support changes to the types of questions being asked of the process and how each person is reacting to the information. It is critical to the long-term success of re-implementation that we are able to translate the IPM training into actionable behaviours in every aspect of our business. This will require change, but through effective feedback and mentoring, the majority of staff will migrate to what is expected and successful. Without staff changing their behaviours, operators will not change and simply react to the real behaviours of their superiors.

5.2.6 Re-Implementation

The first part of the implementation strategy is for each business unit to review their current KIVs and KOVs. The review would need to be completed in a similar manner as the initial implementation with a team of operators, production staff and production engineers. Part of the review would be to complete a statistical analysis of the key variables to determine whether they are in fact linked. The second part of the review is to analyze and compile the other methods that the plant currently uses to manage the process outside of IPM and how the new IPM system

would capture the information. Assuming it can all be incorporated into one system, then the business unit can establish common, transparent procedures around key variables.

The second aspect is to change how business review meetings are held with regards to process reviews. This would include internal business unit review meetings, weekly operating manager meetings and senior management meetings. The information reviewed and questions asked will change the behaviours in the plants. Currently, most of the reviews focus on KOVs and very limited discussion around long-term trends and cost of variability. By challenging the organization to review KIVs in more detail and ask more questions around process capability, it will start creating the change required to focus on the process.

5.2.7 Establishing the Continuous Improvement Process

One telling response during the IPM survey is not one person interviewed felt we were completing Step 6 - the continuous improvement process. Most felt that any improvement initiative was ad hoc based on an individual's experience or a reaction to a plant upset. In particular, operators annotate each data point that is out of conformance with standard comments that roll up into pareto charts. No one including the four operators interviewed felt that the information was being used effectively. This is re-enforced by the fact that only one business area out of five is completing six-month KOV reviews. As a result, only 20% of the business unit is attempting to complete a statistical review of their capabilities.

A system needs to be developed to capture and drive continuous improvement projects and engage the organization in making them a priority. The daily and weekly reviews address basic plant management of the key variables, but the true effectiveness around process management is through making improvements. The previous implementation of IPM was able to achieve success simply by making operators follow the same direction. Once those gains were made and celebrated, the focus on the initiative lost momentum and new wins were not achieved. This implementation has to focus on Step 6 improvement projects to achieve those wins and build momentum for continuous improvement. The information being gathered in the system and by operators using the system needs to be used to improve the plant. Every person interviewed felt by not completing Step 6, we were missing a significant opportunity to improve plant performance and develop strong buy-in for the system itself. The champion will need to establish the methodology for finding and solving Step 6 projects that are in place concurrently with the re-implementation to demonstrate the value of improving our process management processes.

5.2.8 Long Term Organizational Structure Changes

The last aspect of the path forward is to review options to implement an organizational structure that supports long-term process management systems. The IPM champion role was implemented to ensure the proper implementation of IPM between 2001-2003. Following the implementation, the title changed to an IPM coordinator and they reported to a support organization and not directly to operations. The influence the coordinator had to make change and ensure people continued to follow expectations greatly diminished at that point. Once the coordinator role was no longer established, there was no longer any focus on core IPM values from the original implementation. Considering there was no follow-up training especially for new people in all roles, then the system and expectations originally established could not be expected to survive long term. This is supported in the survey with 93% of staff interviewed stating they were not aware of a controlled document summarizing their responsibilities.

Once the re-implementation plan has been completed, the champion's role needs to change into a sustaining function. The sustaining function has to be aligned with operations, continue to manage and drive Step 6 projects, and be a gatekeeper to ensure the IPM systems are being followed and managed. Ideally, Trail's current Chief Metallurgist would eventually assume those responsibilities. The Chief Metallurgist reports to the Production Manager and is responsible for ensuring Trail's metallurgical processes are being optimized with the right feeds while monitoring process upsets. The controlled document on IPM describes the Chief Metallurgist role is to complete Trail level KOV reviews and attend Business Unit Reviews to ensure any process changes are aligned with the current metallurgical plan.

The recommendation would be to expand the Chief Metallurgist's role to include being a gatekeeper for IPM and coach the production engineers, production superintendents and operating managers on process management. Through supporting the production engineers to complete effective statistical analysis of parameters and ultimately troubleshooting of values, it would provide the necessary support to manage the high engineer turnover. Since the Chief Metallurgist reports to the Production Manager, they would have the ability to work with production staff to improve daily and weekly IPM reviews to ensure consistency and effectiveness. The Chief Metallurgist would be responsible for ensuring the weekly production reviews are focused on the right variables and are looking at process variability. Lastly, the Chief Metallurgist would be responsible for coordinating and assigning resources to complete Step 6 projects. The results of the projects would be communicated with Trail Operations on a quarterly basis.

Due to the scope of work and current turnover, there may be a need to have a separate Lead and Zinc Principal Metallurgist responsible for each process management stream. They both would still need to report to the Production Manager and have the same level of authority as a Business Area Operating Manager.

6: Change Management

The purpose of this last section is to outline what is required for successful long-term change management. Considering Trail Operations implemented IPM in 2001 and the subsequent results of the employee survey in 2011, proper change management principles need to be addressed. In order to improve the likelihood of success on re-implementing IPM, this analysis will outline how the implementation plan will address John Kotter's eight steps of transforming an organization.[xxxvii] John Kotter's article, "*Leading Change, Why Transformation Efforts Fail*", originally published in 1995 outlines eight critical success factors that remain relevant today to achieve successful change management.[xxxviii] Each of John Kotter's eight steps to transforming your organization – as summarized below - will be analyzed[xxxix]:

- Establishing a sense of urgency within Trail Operations to improve process management and re-implement IPM.
- Forming a powerful guiding coalition to support the different aspects of the implementation process.
- Creating a vision that Trail Operations effectively conveys with a sense of urgency.
- Communicating the vision throughout Trail Operations.
- Empowering others to act on the vision as a part of the implementation plan.
- Planning for and creating short-term wins by specifically identifying projects that would lead to high profile business improvements.
- Ensuring a strategy for consolidating improvements and producing still more change is a part of the IPM implementation plan.
- Institutionalizing new approaches for future successes and required changes.

By addressing these eight critical success factors during implementation and utilization of IPM, it will allow Trail to achieve operations excellence.

6.1 Establishing a Sense of Urgency

This section will demonstrate there is a sense of urgency in Trail Operations. Trail's production performance over the past five years has not been good. In addition, Trail's aging infrastructure requires significant capital to be re-invested into the business units in order to keep it in operation over the next ten years. In order to solicit the necessary funding to complete the plant upgrades, Trail Operations needs to maximize its profitability and provide confidence that we will be able to deliver on the investments in the future. Otherwise, Trail Operations will not be able to sustain its operation. This is being well communicated as Trail is in the process of putting forward a project to replace our acid plants in the Roaster business area. The approximate project cost will be around $200 million dollars and it must be replaced in the near future for Trail to continue to operate. Assuming the project is approved, there are several more large cost items that will also need to be replaced in future years. These projects are contingent on Trail Operations meeting profitability and production targets.

There is increased competition in the world zinc and lead market in particular from China. This increased competition has reduced Trail's profitability by driving up the cost to purchase concentrate. China is also in the process of building a new lead smelter using the same technology as Trail currently uses. Because the cost of capital in China is so much lower than in North America, there have been reports of more planned expansions in China to modernize their zinc plants. This will result in more efficient plants with greater capacity thus increasing the world competition for concentrate to supply the smelters. To emphasize the increased world competition, a Canadian zinc refinery, Kidd Creek, shutdown in April 2010. This closure has re-enforced to Trail that we need to ensure we are doing everything possible to remain competitive for the future.

Lastly, the sense of urgency for change is a function of the high turnover. The new employees want to ensure Trail is viable for the long term. Most new employees are also significantly more computer literate than the previous generation and are able to utilize the new technology more effectively. Trail has increased its hiring criteria in comparison to 30 years ago and the minimum standard for hiring is a high school diploma, but many of the new hires have supplemental education. Since much of IPM is computer based, the new workforce will be able to grasp the concepts and application more effectively. They are asking to be engaged and want to understand the processes to improve Trail's overall performance. Since we are currently in the middle of significant turnover, the opportunity to change behaviours in new employees must be made now before their current habits are too entrenched causing a larger hurdle for change.

6.2 Forming a Guiding Coalition

This section will show how to establish a guiding coalition to drive change. Establishing a guiding coalition involves establishing a steering committee that supports the IPM champion. The sponsors of the change will be the General Manager and Production Manager, however, the steering committee will be the start of the coalition. The focus of the coalition has to be on bringing the support groups and key business units together to make change. The key groups required include:

- Key personnel from the Leaching and Lead Smelter Business Areas. These business areas have the highest level of complexity and parameters to manage in order to keep the processes in control. Secondly, each business area currently has very strong technical superintendents that believe in IPM and want to re-implement IPM. Once both areas have re-established the proper process and supported the implementation of a new computer system, the other business areas will follow their lead.
- Chief Metallurgist. This person's role is to ensure the high level KIVs and KOVs are established and then be a part of the implementation to eventually assume the role of champion once IPM has been fully implemented.
- Representation from IT. They will be responsible for implementing the new computer system and will need to understand the plant's requirements for using the information effectively. Likewise, being a part of the committee will allow them to communicate IT's requirements for gathering information and what the options are within the computer system selected.
- Representation from Technical Support. Trail Operations has a technical support group that is responsible for working on longer term technical projects or support the plants in major process upsets. They are an end user of IPM data and use the information as a part of the development projects being worked on.

Once the implementation process is progressing well in Leaching and Lead South, then the steering committee must expand to include members of the other business areas at each level of the organization. For example, the Production Superintendents of the Leaching and Lead South business area would lead the transfer of knowledge and systems to the other three business areas. It would be far more effective for people in the same roles to initiate the implementation in the other areas.

6.3 Creating a Vision

This section will analyze further the implementation of the vision statement and how it fits into to Trail's success. In order to effectively implement the IPM vision, it needs to be linked to Trail's guiding principles. Trail's guiding principles are what all of Trail's actions need to reference. The fundamentals of IPM are a guiding principle that can be applied to everything Trail represents. An example of a new guiding principle would be, "We are all responsible for quality and our actions strive for continuous process reliability and improvement." We need to be passionate about our collective responsibility for quality in everything we do. We need to be passionate about reliability in everything we do. We need to be passionate about continuous improvement in everything we do. The message has to be if we are not passionate about these things, Trail will not be successful in the long term. Trail's tag line in public advertisements is, "Leaders in innovation". We need to capture that as a part of our guiding principle of what Trail represents today and for the future.

The second part of the vision is to communicate what IPM is trying to achieve in simple terms. Ultimately, having effective process management should result in very stable processes that are in a strong position to handle any process upset. Having a tag line – "Boring is good" would be an effective way of getting everyone's attention on trying to achieve consistency in everything we do. The vision should encourage each operator to control the process the same way, each engineer to analyze the process the same way, and management to ask questions about the process the same way. By being boring, this allows everyone the time to focus on ideas for continuous improvement instead of process emergencies.

Both tag lines will require Trail to follow-up with action. It will be critical during the initial implementation to recognize performance along those lines and communicate this recognition to the entire organization. In particular, acknowledging performance based on the IPM parameters instead of overall production numbers would send a strong signal of where everyone's focus should be. Equally critical, actions that do not support the vision and objective of supporting IPM will also need to be addressed strongly so that the organization understands the importance of the changes required and vision to be followed.

6.4 Communicating the Vision

This section will outline how to develop the communication strategy to ensure ongoing momentum. Communication of the vision will require an intense effort from all levels of the

organization. It has to start with the General Manager or Production Manager meeting with all personnel communicating the start of the project. Ideally, this would be in the form of crewtalks to allow for two-way discussion on why the initiative is important and the expectations of achieving that goal. Part of the discussion also has to emphasize the sense of urgency of the re-implementation efforts. This will be the critical part of the discussion.

Once the initial communication is complete, all communication methods at Trail Operations must be used. This would include using Trail's local internet site, email, crewtalk, staff update sessions, and essentially every opportunity to provide an update on where the initiative stands and promote positive performance. Regular initiative updates can be sent out to all employees on a monthly basis supporting the key aspects of the initiatives as well as communicating progress to the original plan. Even the use of stickers and posters with the tagline to get everyone's attention to the goal is critical to achieving the initial momentum. Once the initial momentum is achieved, then it will be critical to communicate and celebrate successes achieved through implementation and tie those successes to Trail's bottom line. This will be key to leveraging the initial momentum into something sustainable.

Once IPM has been re-implemented, the next step in effectively communicating IPM's priority is by linking it to the Staff and Hourly Bonus Plan. Currently, there is a bulletin that is issued monthly that summarizes the Trail Operations performance in comparison to the bonus targets. The bonus targets include safety, costs, and production. The next step is to communicate Trail's production performance and relate it to IPM performance. If we communicate and demonstrate how they are related, then its communication and relevance to all will increase significantly.

6.5 Empowering Others to Act & Creating Short-Term Wins

This section will describe how focusing on short term wins can achieve empowerment within a few business units to build momentum for change through the rest of Trail Operations. In particular, this section will highlight specific areas that would be ideal candidates to focus on during the implementation for high profile short-term wins.

Focusing IPM implementation in the two highest complexity plants provide several opportunities to plan for short-term success. Both business units are key to Trail achieving production targets and overall, drive decisions within Trail's metallurgy. In particular, each business area has at least two areas that would provide for visible, significant short-term wins.

Part of the IPM re-implementation would be to focus on these areas and at the same time, start Step 6 projects targeting improvements in these areas.

In Leaching, improving first pass zinc recovery and reducing zinc dust consumption has direct, measurable impact to Trail's bottom line. Zinc dust is an internal recycle of zinc that is used to purify zinc electrolyte and by reducing the amount used, it increases the amount of zinc actually sold to market. Increasing first pass zinc recovery reduces the amount of zinc recycled to the lead smelter. Although zinc treated by the smelter is recycled back to the zinc circuit, it prevents the smelter from treating higher valued concentrates containing high zinc levels since the lead smelter has a metallurgical upper limit on zinc treatment.

In the Lead Smelter, reducing recycle dust production and improving control of the Continuous Drossing Furnace (CDF) also has direct, measurable impact to Trail's bottom line. Recycle dust is a by-product of the combustion reaction in the lead smelter and is a reflection of how efficiently the reaction is occurring. By reducing recycle dust production, this would allow the lead smelter to increase production rates as the amount of recycle dust produced limits production rates. Improving control of the CDF has been extensively worked on in the previous several years with success. However, further work is required to transfer the previous learnings to make them transparent so that the same mistakes do not occur in the future. Previous restrictions on the CDF restricted lead smelter production significantly over the past several years. The progress and success of the projects must be communicated to the organization to ensure everyone has an understanding of the value of what is being worked on and develop ideas and data for future improvement projects.

Once those projects have been initiated, it will be the champion's responsibility to initiate Step 6 projects in each of the next areas that IPM is rolled out in. Once the rollout is complete, once a Step 6 project is complete, another project will need to be initiated in that area to maintain the momentum. Long term, the Chief Metallurgist will have the responsibility of ensuring Step 6 projects are ongoing and are properly communicated to the organization as a whole.

Successful empowerment will be achieved when each plant works on each of the above opportunities. Part of the initial IPM implementation success was empowering the operators to be a part of selecting the proper KIVs and KOVs for a plant. During the re-implementation, each plant will have to develop a team of operators and operations staff to review the information currently in the system and how to apply that information into the new computer system. The purpose of the team will be to ensure operators are a part of the setting up the process, understand what is required and in turn, feel empowered to make future changes.

The second part of the empowerment is utilizing key personnel from each of the two business areas, Leaching and Lead Smelter, to support the re-implementation into the subsequent business areas. This will provide the initial business areas with ownership that what they will be working through will be applied across Trail Operations and they will be directly involved in its successful implementation. Secondly, the other business area's personnel will be working predominately with their peers supporting the implementation. This will help with coaching personnel in overcoming roadblocks and provide the necessary perspective if changes need to be made to process as a whole to be successful. Specifically, the key individuals would include senior operators, production engineers, shift leaders and production superintendents. Assuming the two pilot areas are successful in implementing the changes, then utilizing the pilot areas will only help the guiding coalition.

6.6 Consolidating Improvements

This section will highlight the strategy to consolidate improvements. IPM is not something where victory should ever be declared. The focus has to be on continually improving the process and celebrations should be for the short-term project wins and celebrating "boring" achievements. Ultimate victory is achieving and surpassing production targets - process management requires ongoing training and education to ensure success is realized for the long term. Otherwise, similar to what has happened with the last IPM implementation, momentum will be lost and business units will lose sight of the basics of what is required to be successful.

Part of consolidating improvements is to recognize leaders in process management and promote them accordingly. This would take into consideration their ability to engage others to become passionate about process management, manage the monitoring systems effectively and drive continuous improvement projects. The opposite would also be true in dealing with those whom do not support re-implementation especially at the senior levels. Otherwise, they will eventually undermine the key processes required for "re-implementation" of IPM. If as an organization we believe IPM is critical for Trail Operations long-term success, then no one individual should be larger than the initiative itself.

6.7 Institutionalizing IPM

This section will address the key issues to ensure long-term success of IPM in Trail. In order to institutionalize IPM, its long-term inclusion in Trail's plans has to be communicated to the organization. Part of the long-term plan is to communicate the vision of transferring IPM

management from the champion to the Chief Metallurgist upon re-implementation in all the business areas. This will signal to the organization that there is a plan to ensure its ongoing support and drive at a senior level. Since the Chief Metallurgist is currently responsible for overseeing Trail level KOVs, this will help drive increased involvement with related KIVs.

The second aspect is to ensure the six-month KOV reviews are re-instituted and managed by each business area. The Chief Metallurgist will be a part of these reviews and ultimately, be responsible for their effectiveness. The six-month KOV review is critical for initiating Step 6 continuous improvement projects and challenging the business to improve their control of several key variables. The six-month review would also provide an opportunity for the original implementation team to participate and be a part of any improvement project or follow-up to plant management issues. Since operators will be a part of the team, this will provide operators with an opportunity to challenge how IPM is being used and offer suggestions for improvement beyond the weekly reviews.

Another aspect to changing the culture is to change how senior level business reviews are completed and include IPM parameters as a part of these reviews. This could mean including IPM parameter targets as a part of the yearly tactical plan and challenging each business area for improvement. Ultimately, the discussions and questions at a senior level need to reflect the new focus or there will be no incentive for change in each of the business units. Assuming the guiding principles are changed, there needs to be changes on the questions we ask regularly around quality, process reliability and continuous improvement.

7: Conclusion

Trail Operations implemented IPM in 2001 to achieve operations excellence. Results were achieved within two years of implementation by decreasing process variability and thus improving production and quality. An employee survey of management staff has indicated that ten years later, IPM is no longer an effective tool for managing the process. The survey highlighted several issues with regards to lack of training and education, original systems not being followed, roles and responsibilities being unclear, and no formal continuous improvement process. In addition, the IPM computer system was highlighted as a key issue due to its lack of functionality and the fact it is obsolete. Lastly, high employee turnover at all levels of the organizational have contributed to the organizational knowledge loss of IPM. Considering the survey indicated a lack of training and education as a key issue, high employee turnover significantly contributes to making IPM an ineffective process management tool.

The cost of failure of not meeting Trail's production plan for lead and zinc over the past five years is an approximate loss of $29.7 million dollars. Although not all of the production losses can be attributed to poor process management, high process variability does not allow for flexibility in dealing with process upsets. Trail Operations needs to be able to demonstrate strong operational performance in order to generate revenue to allow capital to be re-invested into major projects essential for Trail long term viability. Employee turnover will continue to be at a high level over the next five years with over 500 personnel retiring. Without any process management process, the result of even higher process variability will only increase. Lastly, there is increased competition in the world zinc and lead market in particular from China which has reduced Trail's profitability in being able to purchase concentrates. To emphasize the increased world competition, a Canadian zinc refinery, Kidd Creek, shutdown in April 2010. This closure has re-enforced to Trail that we need to ensure we are doing everything possible to remain competitive for the future.

The key for Trail Operations to achieve operations excellence is to re-implement IPM. This includes resurrecting and re-implementing the behaviours, systems and vision that were originally implemented in 2001. Without this structured system, as indicated in the survey, each business area will rely on the skills and experience of the personnel in the business area to manage the process. Considering the high turnover, this will become less effective. Re-

implementing IPM allows the organization to harness the remaining organizational process knowledge and transfer that knowledge to newer operators to achieve process stability. Production engineers and operations staff have clear roles and responsibilities to manage the process as well as a defined process to achieve continuous improvement. It will be through continuous improvement that Trail Operations will be able to make the gains required to remain competitive in the future.

The implementation strategy will require the organization as a whole to rally around the importance of IPM at every level of the organization. A strong champion needs to be selected to lead the change initiative with strong support from senior management. The IPM computer system will need to be upgraded and compliment the current systems in each plant. Training and education programs will need to be initiated and the support systems for operators, engineers and operations staff will need to be re-established. Lastly, the continuous improvement process will need to be initiated with a focus on several high profile issues to demonstrate success and momentum for future improvements.

With the issues facing Trail Operations today and into the future, Trail must improve its process management. IPM was previously implemented to achieve that goal with success and support from the entire organization. It will need to be effectively re-implemented in 2011to achieve operations excellence for the future.

Appendices

Appendix A – IPM Survey

Objective of the survey is to understand the level of process management understanding and usage of IPM in each of the operating areas.

Summary of Results

Summary of IPM General Survey – Completed February 7th to February 18th, 2011

Question	Results
Are you aware of the IPM controlled document and your responsibilities within it?	93% of staff responded no – they were not aware of the document and the expectations with it.
If IPM failed , does it matter?	68% stated no. They currently use other methods to help manage the process.
Is IPM used effectively?	Yes = 16%, Moderately = 34%, No = 50%
Is your understanding of roles/responsibilities within IPM clear?	57% said no.
Are you KIV or KOV focused?	65% stated KOV focused.
Are we doing Step 6 – continuous improvement?	100% stated no.
What kind of process management training have you received over the last five years?	97% said zero hours.
Evaluation of crew knowledge of IPM?	Strong = 10%, Variable = 52%, Weak = 38%
Results based on 31 interviews within different levels of Trail Operations. This included 27 staff from different levels of the organization and 4 operators.	

Key areas for improvement:

- Training
- Improved tools – operator use, engineer analysis
- Linkage of all "systems"

Survey Questions

Production Manager

1 - What is your understanding of process management in 30 seconds or less?
2 - Do you follow roles and responsibilities as outlined in D4672?
3 - Have you attended a KOV review? What is your expectation?
4 - What is your understanding of Step 6?
5 - How do you use IPM daily (ie. relationship tree, daily IPM conformance reports, Qlikview...)?

Weekly?

6 - What would you do if the computer system failed? What 2 things would you improve with the IPM computer system?

7 - What kind of questions do you ask around process variability?

8 - Do you think we use the information effectively?

9 - How do you evaluate process performance - KIV or KOV focus? How do you use the IPM process tools?

10 - Outside of IPM reviews, what other types of meetings/reviews are held to review the process? What is reviewed and how?

11 - What kind of process mgmt training have you received? What kind of training do new employees (Ops, Engs, Mgmt staff) receive?

12 - What does "create a positive environment" mean to you (reference Step 1)? How is IPM performance communicated to the organization?

13 - What is the crews understanding of IPM? How do they use it to manage the process? Troubleshoot?

14 - If you had 2 things you would improve with regards to process mgmt, what would they be?

15 - Other feedback?

Chief Metallurgist

1 - What is your understanding of process management in 30 seconds or less?

2 - Do you follow roles and responsibilities as outlined in CD4672?

3 - Do you conduct KOV reviews? Is so, how often? How are the actions managed and minutes published?

4 - What is your understanding of Step 6? Are you a part of it?

5 - How do you use IPM daily (ie. relationship tree, daily IPM conformance reports, Qlikview...)? Weekly?

6 - What would you do if the computer system failed? What 2 things would you improve with the IPM computer system?

7 - What kind of questions do you ask around process variability?

8 - Do you think we use the information effectively?

9 - How do you evaluate process performance - KIV or KOV focus? How do you use the IPM process tools?

10-Outside of IPM reviews, what other types of meetings/reviews are held to review the process? What is reviewed and how?

11 - What kind of process mgmt training have you received? What kind of training do new employees (Ops, Engs, Mgmt staff) receive?

12 - What does "create a positive environment" mean to you (reference Step 1)? How is IPM performance communicated to the organization?

13 - What is the crews understanding of IPM? How do they use it to manage the process? Troubleshoot?

14 - If you had 2 things you would improve with regards to process mgmt, what would they be?

15 - Other feedback?

Operating Manager

1 - What is your understanding of process management in 30 seconds or less?
2 - Do you (and your organization) follow roles and responsibilities as outlined in CD4672?
3 - Do you conduct KOV reviews? Is so, how often? How are the actions managed and minutes published?
4 - What is your understanding of Step 6? Are you doing it? How?
5 - How do you use IPM daily (ie. relationship tree, daily IPM conformance reports, Qlikview...)? Weekly?
6 - What would you do if the computer system failed? What 2 things would you improve with the IPM computer system?
7 - Does your organization conduct daily, weekly IPM reviews? What kind of questions do you ask around process variability?
8 - Do you think we use the information effectively? Annotation feedback?
9 - How do you evaluate process performance - KIV or KOV focus? How do you use the IPM process tools?
10 - How do you manage IPM accountability (ie. your definition of roles/responsibilities, follow-up on action registries…)?
11 - Outside of IPM reviews, what other types of meetings/reviews are held to review the process? What is reviewed and how?
12 - What kind of process mgmt training have you received? What kind of training do new employees (Ops, Engs, Mgmt staff) receive?
13 - What does "create a positive environment" mean to you (reference Step 1)? How is IPM performance communicated to the organization?
14 - What is the crews understanding of IPM? How do they use it to manage the process? Troubleshoot?
15 - If you had 2 things you would improve with regards to process mgmt, what would they be?
16 - Other feedback?

Production/Group Superintendent

1 - What is your understanding of process management in 30 seconds or less?
2 - Do you (and your organization) follow roles and responsibilities as outlined in CD4672?
3 - Do you conduct daily IPM reviews? Do you conduct weekly IPM reviews? How are the actions managed and minutes published?
4 - What is your understanding of Step 6? Are you doing it? How?
5 - How do you use IPM daily (ie. relationship tree, daily IPM conformance reports, Qlikview...)? Weekly?
6 - What would you do if the computer system failed? What 2 things would you improve with the IPM computer system?
7 - Do you think we use the information effectively? Annotation feedback?
8 - How do you evaluate process performance - KIV or KOV focus? How do you use the IPM process tools?
9 - How do you manage IPM accountability (ie. your definition of roles/responsibilities, follow-up on action registries, S/L usage, operator annotation quality)?
10 - Outside of IPM reviews, what other types of meetings/reviews are held to review the process? What is reviewed and how?
11 - What kind of process mgmt training have you received? What kind of training do new

employees (Ops, Engs, Mgmt staff) receive?

12 - What does "create a positive environment" mean to you (reference Step 1)? How is IPM performance communicated to the organization?

13 - What is the crews understanding of IPM? How do they use it to manage the process? Troubleshoot?

14 - If you had 2 things you would improve with regards to process mgmt, what would they be?

Production Eng's

1 - What is your understanding of process management in 30 seconds or less?

2 - Do you follow roles and responsibilities as outlined in CD4672? Do you conduct capability analysis on IPM system requirements?

3 - Do you involved with daily IPM reviews? Do you involved with weekly IPM reviews? How are the actions managed and minutes published?

4 - What is your understanding of Step 6? Are you doing it? How?

5 - How do you use IPM daily (ie. relationship tree, daily IPM conformance reports, Qlikview...)? Weekly?

6 - What would you do if the computer system failed? What 2 things would you improve with the IPM computer system?

7 - How do you evaluate process performance - KIV or KOV focus? How do you use the IPM process tools?

8 - How do you manage IPM accountability (ie. your definition of roles/responsibilities, follow-up on action registries, overall plant usage, operator annotation quality)?

9 - Do you think we use the information effectively? Annotation feedback?

10 - Outside of IPM reviews, what other types of meetings/reviews are held to review the process? What is reviewed and how?

11 - What kind of process mgmt training have you received? What kind of training do new employees (Ops, Engs, Mgmt staff) receive?

12 - What does "create a positive environment" mean to you (reference Step 1)? How is IPM performance communicated to the organization?

13 - What is the crews understanding of IPM? How do they use it to manage the process? Troubleshoot?

14 - If you had 2 things you would improve with regards to process mgmt, what would they be?

Shift Leaders

1 -What is your understanding of process management in 30 seconds or less?

2 - Do you follow roles and responsibilities as outlined in CD4672? How do you manage crew accountability with regards to IPM (ie. reaction to out of conformance, annotations)?

3 - Are you involved with daily IPM reviews? Do you involved with weekly IPM reviews? How are the actions managed and minutes published?

4 - What is your understanding of Step 6?

5 - How do you use IPM daily?

6 - Do you think we use the information effectively? Annotation feedback?

7 - What would you do if the computer system failed? What 2 things would you improve with the IPM computer system?

8 - How do you evaluate process performance - KIV or KOV focus? How do you use the IPM process tools?

9 - Outside of IPM reviews, how else is the process reviewed?
10 - What kind of process mgmt training have you received? What kind of training do new employees (Ops, Engs, Mgmt staff) receive?
11 - What does "create a positive environment" mean to you (reference Step 1)? How is IPM performance communicated to the organization?
12 - What is the crews understanding of IPM? How do they use it to manage the process? Troubleshoot?
13 - If you had 2 things you would improve with regards to process mgmt, what would they be?

Operators

1 - What is your understanding of process management in 30 seconds or less?
2 - How do you use IPM? Does it help manage the process proactively or reactively? Troubleshooting?
3 - Do you think we use the information effectively? Annotation feedback?
4 - Are you involved with IPM reviews?
5 - What is your understanding of Step 6?
6 - What would you do if the computer system failed? What 2 things would you improve with the IPM computer system?
7 - Outside of IPM reviews, how else is the process reviewed?
8 - What kind of process mgmt training have you received? What kind of training do new employees (Ops, Engs, Mgmt staff) receive?
9 - What does "create a positive environment" mean to you (reference Step 1)? How is IPM performance communicated to the organization?
10 - Crews understanding of IPM?
11 - If you had 2 things you would improve with regards to process mgmt, what would they be?

Responses

Production Manager

Questions	Responses
1	Controlling process to expected ranges to operate efficiently.
2	Yes – in a general sense.
3	Attended 1 KOV since starting the current role 8 months ago at the Electrolytic and Melting plant. No other invites to meetings nor formal IPM specific reviews.
4	Step 6 – continuous improvement. General sense is improvement projects are generated on an adhoc basis.
5	No. Don't use regularly.
6	Yes, does care if IPM failed. Believe there is lots of opportunity for improvement to improve overall process management. We need some sort of system to help provide that direction.
7	-
8	No – lots of opportunity for improvement to improve our consistency and troubleshooting.
9	KOV focused although does ask questions around specific KIVs for a few of the plants.
10	Weekly Operations meetings, Plant specific recovery meetings, Trail Senior Management business reviews (specific focus on Trail level KIV and KOVs)
11	Over the past 10 years, no training as was in the commercial group. Prior to that, received specific IPM training twice. Was a part of the original implementation in 1992-1993.
12	Does not believe IPM specific performance is effectively communicated across the organization. Step 1 activities are a good opportunity for improvement.
13	Believe some crews use it along with using other control system information (ie. PDE, PDH, various control systems). Other crews less so. In particular, ability to find root cause of issues is variable and certainly there are training opportunities for all levels of the organization.
14	2 overall things to improve – general management review of process management and IPM, and overall training.
15	-

Chief Metallurgist

Questions	Responses
1	Maintaining key variables within statistical control. Focus on KIV's and then that allows for KOVs to be in control. Consistent operation.
2	No.
3	Do not currently conduct KOV reviews. Attempted in the past to complete Trail level KOVs. Plant didn't support it. System doesn't work for what you needed it for.
4	Step 6 – continuous improvement. Does not have a role within Step 6. Trail level should be involved. Plant should manage their items.
5	Doesn't use IPM. Recovers process data into spreadsheets for analysis.
6	No impact although it should be a lot more important. 2 things to improve IPM specifically – need the ability to see info at a higher level and easier relationship trees.
7	Not a focus. Does recognize value. Don't ask questions on those terms – look at specific out of conformances.
8	Not always using the information effectively. Some areas better than others.
9	KOV focused – what we report on.
10	Weekly Ops meeting. Raw materials meeting. Review metal suspense every month. Review of raw material balances with financial accounting. Review CSums on key variables from plants and analysis of feeds coming (ie. for write-offs). Complete Monte Carolo simulations for feeds.
11	Nothing in the last 5 years. Have had SPC and IPM training prior. New engineers get limited training. Normal training is through osmosis.
12	Step 1 – needs improvement. In the 1990s, skipped step 1 and that was a mistake. 2nd rollout did better.
13	Crews knowledge is variable. Following the IPM process has shown positive value – gypsum management was a good example.
14	Move towards trends instead of non-conformance and initiating a formalized improvement process.
15	Look to build upon what we already have – a lot of good things are still there; need to fine tune key areas.

Lead North

Questions	Responses
	Operating Manager
1	Identifying key variables that are critical and monitor to ensure within targets and address.
2	No.
3	Don't conduct KOV reviews. Review KOVs during weekly staff reviews. Key parameters established through the Westwind process. Do not track actions outside of specific items that are covered during a weekly superintendent meeting.
4	Step 6 - ?. Done on adhoc basis.
5	No. Use trends and assays.
6	No impact if IPM failed. Need to manage 2 variables in a different way.
7	Only Lead refinery has IPM (ie. process reviews) every 2nd day. No formal process.
8	We could use information a lot better.
9	KOV focused.
10	-
11	See above.
12	No training. Learning on the fly. Engs – a part of their schooling and through exposure in other plants.
13	Step 1 – as per current safety initiatives.
14	Crews understanding variable between plants and jobs. Weak troubleshooting skills.
15	2 ideas – process training and look for opportunities to increase process control.
16	If you could integrate PDE especially comments with IPM, that would be a step forward. Overall, feels that there was a poor initial implementation in Lead North that ultimately lead to its lack of use.
	Production Superintendent / Group Superintendent (3)
1	Steps to a desired outcome. Specific targets to achieve and focus on actions to address. Looking at key variables in process and managing to target. Maximize process objectives.
2	Not following nor aware of the document. Copper products and ETP IPM system not working. Silver only using trends from PDH system – IPM did not work for batches effectively. Used in Lead refinery for a few variables for tracking only.
3	No IPM reviews. Have daily reviews of trends and process discussions during pre-shift meetings. Issues dealt with as they are brought up. Lead refinery has IPM meetings every 2nd day with S/L, Ops, Eng and P/S.
4	Step 6 – didn't get there. Ops not involved and did not catch on. No KOV reviews – since 2006-2007! Using the PDE so not looking at longer trends effectively. During IPM implementation, there was too much info, too fast. Current Westwind

	initiative filtering info and allowing to focus on a few key variables.
5	Do not use IPM except for 1 or 2 variables. Do not use any of the other tools.
6	It doesn't matter if IPM failed. Just need to track a few variables differently. In saying that, they want to find a way to use what it was intended for. 2 things to improve the IPM system – improve operator interface and make it windows based. Other ideas for improvement – needs to support batches and focus on front line leader interfaces and management.
7	Lots of opportunity using the information more effectively.
8	KIV focused in ETP. KOV in the other plants.
9	-
10	-
11	Last 5 years – can't remember. Did have IPM training upon implementation. Current training is from peers.
12	Step 1 – ongoing challenge. Improved in this area though in last few years.
13	Crews understanding minimal at best.
14	Improvement ideas – focus on batch process and pick what is important to focus on (ie. not everything) Other comments: Training – MTS training system is a good thing and would add value. Management stopped pushing it. Lead North is mostly a batch process so need to find something that tracks batches to really value.
	Production Engineers (2 – both have less than 3yrs experience)
1	Understanding what is important to your process. Keeping an eye on them and managing them. IPM allowed for tracking and retain key learnings.
2	No and no process capability analysis.
3	Refinery – every 2 days. Discuss key items but no minutes. Silver – informal discussions. Still use paper system in some regards.
4	Step 6 - ?. Improvement projects justified by expectations.
5	Don't use it.
6	No issues with system failure. Need to track 2 parameters separately.
7	Mix of KIV and KOV.
8	Difficult to manage shift issues. Hard to rollout process changes.
9	No – could be better.
10	See above.
11	No SPC training. Learn on the job and lunch/learn sessions. Everyone else – very limited if at all.
12	Step 1 – improving in this area.
13	Crews have limited understanding. Experienced guys understand their plants –

	new people struggling.
14	2 ideas – need something for batches and training.
	Shift Leaders
1	Control of inputs and outputs
2	No. A little bit more accountability with the implementation of Westwind.
3	It died previously but is restarting with westwind.
4	Not really. Overall, guys don't know why they are using IPM. It needs a major purging of what used to be there.
5	Not looked at regularly – maybe once per run.
6	Do not use IPM effectively but use the other systems well.
7	Nothing. 2 things to improve – easy to move into history and integrate into LIMS
8	KOV. Do not use process tools.
9	Daily reviews and by exception as required.
10	0hrs. New employees do not get specific training – strictly SOPs.
11	Step 1 in Pb N ok. Focus groups support this.
12	-
13	Training, more integrity (ie. relevance of info in it).
	Operators (new relief leader out that day)
1	Limited!
2	Don't use it.
3	?
4	As an operator, no.
5	?
6	Nothing.
7	With shift leader as required.
8	0hrs. Learn from others.
9	? – housekeeping has improved.
10	Very little understanding.
11	?

Electrolytic and Melting

Questions	Responses
	Operating Manager
1	Ensuring process running between standards set. Ensuring consistency among plant. Manage process when things bad.
2	Maybe!
3	Yes! Every 6 months. Summarize conformances and develop actions to address issues. Invite Eng customer.
4	Step 6 – continuous improvement step. Mostly completed as adhoc although a few projects would be considered step 6 (ie. Zn dust improvement).
5	Scan it almost every day – 3 screens in particular. Don't look at trees, conformance reports or Qlikview.
6	No issues with IPM failing short term. After a week though, would need something to collect the IPM data (if required). 2 things: more tools for the Eng and need something more for the relationship tree.
7	Daily mtg's for both plants. A formal IPM meeting every 2 weeks. Does ask questions around process variability by exception.
8	Not really – don't use the pareoto info.
9	KOV focused.
10	P.Eng drives it. Believes roles and responsibilities clear.
11	Weekly meeting covers process aspects.
12	Last 5 yrs = 0hrs. Was a part of 2nd IPM implementation. Limited to no training for others. Mostly learn from osmosis.
13	Step 1 – doing well with the westwind focus groups. IPM isn't specifically communicated; westwind initiatives are.
14	Crews – ELT control room understand it. Limited for the rest.
15	2 things – better tools to analyze the data and have 1 system for the information.
16	-
	Production Superintendent / Group Superintendent (2)
1	Set standards and run to standards.
2	No.
3	No daily reviews. Every 2 weeks with Production Eng.
4	Step 6 – didn't do it. Ad hoc improvements.
5	Look at slide show daily. Don't use any of the reports.
6	Yes. Use it to look at trends! 2 things to improve – trending important and add more trending options
7	Info not used properly. Don't care about annotations.
8	Both – KIV/KOV

9	Roles and responsibilities not clear.
10	Nothing beyond what was noted above.
11	0hrs in last 5yrs. IPM implementation. No training for Ops coming in except quick overview.
12	Step 1 – doing well. Supported by Westwind.
13	Crews – those who were here during implementation understand what the goal was. New people – no. Don't use PCS'. Will use IPM to troubleshoot.
14	Training! Set-up it up so that it can be used at the machines as well.
	Production Engineers – (1 – new hire out of university with 3 months experience)
1	Using tools available to collect data.
2	No…
3	Look at slide show daily. Not a part of daily reviews. Respond as required.
4	?
5	Look at slide show daily. Don't use other reports.
6	?
7	Both
8	Roles and responsibilities not clear.
9	Still learning!
10	See above.
11	0hrs.
12	?
13	Variable between plants.
14	Improve transparency and make system work.
	Shift Leaders (1)
1	Inputting data to help you in different situations.
2	No.
3	Bi-weekly meetings when they are held. Wait for Eng to tell them to do something.
4	?
5	Not used at all. Wait for Ops to let him know.
6	Not sure.
7	No one would care if IPM failed.
8	-
9	Look at data in the control room.

10	1hr with MSC. Otherwise, nothing formalized. Same for operators.
11	Step 1 - ?. Westwind initiative helping with positive environment.
12	Limited. Change dot color.
13	2 things – have it learn on its own and increase training.
	Operators (2)
1	-
2	Not very much. Use PDE. IPM parameters not in their control and waste of time annotating.
3	No.
4	No.
5	-
6	Nothing!
7	-
8	0hrs outside of IPM implementation.
9	-
10	Limited at best.
11	Training and make the systems work together as one.

Leaching

Questions	Responses
	Operating Manager
1	Control process – KIVs lined up with KOVs. Confirm process is steady and in control. Continuous improvement.
2	No.
3	No.
4	Step 6 – continuous improvement. Informal process currently. Tues/Thurs reviews and tweak parameters accordingly. Adhoc improvements.
5	Review daily – go through screens. Look at IPM conformance report, not Qlikview or relationship tree.
6	IPM failing is a big deal!!! Crews used it as logsheets. 2 improvements: data analysis and trending/transparency
7	Daily mtg's cover IPM informally, IPM reviews every 2 days. Use CSums of data to push process variability.
8	Use info ok. Do not use annotations.
9	KIV
10	Review annotation conformances and challenge crews.
11	CSums, Foxboro alarm management system, Condition maintenance management reports
12	Training – KT training, IPM, PDH database… Others based on SOPs or from others
13	Step 1 – normal plant management
14	Crews have a good understanding. Troubleshooting ok.
15	2 things – improve tools for Eng's and standardization of tool usage
16	-
	Production Superintendent / Group Superintendent (3)
1	Goal posts for key variables. Manage to it and change accordingly. Key items for Ops. Controlling process to an agreeable standard and avoid entropy. Catch things before goes out of conformance.
2	No but believe they are following it. No. Do complete capability analysis for final products (DGR)
3	SLP - 2/week. No minutes. SPL – every other day.
4	Continuous improvement. New initiatives adhoc. SPL – offline process reviews.
5	IPM reviewed daily. Also look at other systems as well. Used relationship tree for learning the process but none of the other tools. SPL – have offline process reviews to help manage.
6	Yes, it is important. 2 things – KIV/KOV 1 display, do annotations at once. SPL – yes, important.

7	IPM data usage is reactionary. Not using annotation info.
8	KIV focused
9	Accountability – roles clear. Not pushing annotations
10	Daily morning meeting and as required. SPL – weekly recovery meeting and occasionally with Production Manager.
11	No formal training. Osmosis. Eng's and Ops learn as you go. Recent implementation of IPM helps for Ops. SPL – nothing last 5yrs but had stats course, IPM implementation and information. Rest similar.
12	Step 1 – as per normal plant management.
13	Crews use it especially top tier. Still troubleshoot instinctively. SPL – crews use it because they are told to. We have lost the knowledge on how it is put together. Not using its full potential.
14	More stringest process change and learn as you go. SPL – Improve operators knowledge of process control and stability. Improve interpretation of data so that we can improve our process decisions.
	Production Engineers – (1 – new hire out of university with 2.5yrs experience)
1	Monitoring process – try to achieve targets and evaluate what goes out and causes for the issues
2	No – believe doing it though. No capability analysis.
3	OLP – every other day. No minutes.
4	Step 6 – not formalized. Improvements – day to day firefighters.
5	Use daily. Use relationship tree and sometimes conformance reports. No to Qlikview.
6	If failed, not a major issue. Critical trends on Ops screens. Ops not using IPM properly to manage process. 2 improvements: integrate into ALL training and trends more visible.
7	KOV focused. Not really using trends.
8	Review annotations with Ops.
9	Info used ok for technical and plant management. Operators don't use it.
10	Daily process meeting.
11	0hrs of training. Operators – osmosis.
12	Step 1?
13	Crews understand what is there but don't use it to help manage the process. Not happy using it – just another things.
14	2 ideas – central idea communicated and more of a focus to keep in control
	Shift Leaders
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	Operators
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Roasters

Questions	Responses
	Operating Manager
1	Define inputs/outputs. Understand stability.
2	No.
3	No 6 month reviews. Complete weekly KOV reviews.
4	Step 6 ad hoc although sulphate sulfur performance would be a good example. Roasters also run on autopilot which drives consistency.
5	Use daily to review product quality. Use to use tools.
6	Not really important. Able to manage around it. Ask questions around process variability specific to inventories, storages.
7	Weekly IPM reviews.
8	Not really using effectively. Although use info to run Roasters on autopilot.
9	KIV focused
10	Used to push annotation conformance for quality info
11	Daily and weekly reviews, weekly reports from Engs (good process detail)
12	0hrs over last 5 years. Eng training through osmosis.
13	Step 1 – as per plant procedures.
14	Crews – supposed to operate between limits but actually run between alarm setpoints
15	2 things – get same process template and de-bug autopilot
16	Suggest investing in simulators.
	Production Superintendent / Group Superintendent (2)
1	Overviewing process to make sure on track and look for opportunities. Control of product to a set standard.
2	No.
3	IPM reviews 2/wk. It is used daily to review product spec sheets.
4	Step 6 – improvement. Adhoc based on specific people's experience.
5	Do not use tools.
6	Not a big difference. Maybe feel it in a few months. Need to cut down on the number of variables in the system. 2 improvement items – use it and include SPC tools.
7	Info – opportunity for improvement.
8	KOV
9	Pushing Eng's to understand process through detailed weekly report.
10	Daily meetings

11	0hrs in last 5 years, IPM rollout
12	Step 1 not well implemented
13	Crew don't like it and do it for conformance. Not used to manage process. They use Foxboro trending. Info inputing they already know.
14	Help Eng's learn how to monitor process. Need consistency across Trail in terms of methodologies. Get IPM info in real time and link to current systems with multi-trending.
	Production Engineers – (2 – less than 2yrs experience)
1	Maintain process as best as we can.
2	No.
3	No daily IPM reviews. Bring up issues at daily production meetings.
4	?
5	Review slide show. Do not use other tools/reports.
6	Important ZPL but not RSTs. 2 things: make it more user friendly and multiple trending
7	KOV
8	Roles clear – Eng owns.
9	Info used ok. Question quality of data.
10	Process reporting good although reviewing past. Need something forward looking.
11	Training through osmosis. Have not done online training.
12	-
13	-
14	Training, improve plotting tool, improve perceived value of IPM, add tool to make use of PCS easier
	Shift Leaders
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	Operators
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Lead South

Questions	Responses
	Operating Manager
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	Production Superintendent / Group Superintendent (2)
1	Reliability of process to tie inputs and outputs. Ensure stability.
2	Yes although never read it. No.
3	No daily IPM reviews but do have daily process reviews. IPM reviews variable – 2 to 3 times per week. No minutes – Eng's manage. Complete daily process reviews though.
4	Step 6 – 6 sigma concept. Ad hoc improvements.
5	1/week – slide shows and annotations. Don't use tools. / Use IPM daily but none of the other reports/tools.
6	Don't care per say but plant needs it. SOPs cover the short term. Drossing uses IPM for models and KIVCET is manual entry (not as valuable). 2 improvement items – improve trending and background info not visible. / Yes – but should care more than I do! Believe in it and can be an effective tool.
7	Info not used effectively.
8	KOV focused.
9	Roles and responsibilities not clear.
10	Daily reviews, Weekly process reviews, detailed monthly report

11	No IPM training, 0hrs – new people, nothing specific. All task related.
12	Step 1 – good within current practices
13	Crews – understanding of IPM is retiring quickly. They are tasked based.
14	Same as above. / More training for everyone and initiate Step 6.
	Production Engineers – (2)
1	Control inputs, control how process is managed and outputs. Guys running process doing the same things. Directing process to what we want.
2	No!
3	Weekly when possible.
4	No – analysis not done using IPM tools.
5	Review daily but don't use tools.
6	No! 2 things – improve resolution and timeliness of data
7	KIV and KIV/KOV
8	Roles clear (but no control)
9	Info use ok although value of annotation is non-existent
10	Daily reviews, Weekly process reviews, 1/wk with crews
11	0hrs – informal on IPM, KT training provided, learn from others
12	Step 1 overall good
13	Crews – variable
14	Ensure everyone on same page on priorities, consistency of info and train as to why
	Shift Leaders (1)
1	A way we all agree on how to run the place – formally.
2	Not using it much. Neither is anyone else!
3	Involved in daily reviews but not IPM. Still involved in weekly IPM review.
4	Step 6 – not really, more ad hoc
5	Look at it once/run
6	Don't use IPM info effectively, but use other systems well
7	Don't care if IPM failed. 2 things: easy to move in history, integrate with LIMS
8	KIV
9	Daily reviews and by exception
10	Training = 0hrs.
11	Step 1 ok
12	Crews variable
13	Modernize IPM

	Operators
1	Have a set of standards. Adhere to those standards and explain why we are out of conformance
2	Not very much. Use it at the end of the shift to check what is going on and to annotate. When putting annotations in use the closest standard annotations and not necessarily what was found. Feels 95% of PCO do that.
3	No
4	No
5	When putting annotations in use the closest standard annotations and not necessarily what was found. Feels 95% of PCO do that.
6	Not really an issue still operate process within parameters
7	They are infrequent.
8	Outside of original IPM training, Peer training .. Not much from OI.. more from fellow operators on crew
9	Have people listening. Let operations do their jobs.
10	Waste of money. Ie they don't understand
11	Improve the team aspect of it all (like it was described when it was put in). Get away from changed red to yellow for out of conformance points and focus on the actual why they are out.

Appendix B – Trail Operations Guiding Principles[xl]

Guiding Principles

These guiding principles define what we value, how we behave, and what we expect of others. Living by these guiding principles will ensure Trail Operations' future success.

- We act with **integrity**, treating all with **dignity**, **fairness** and **respect**
- We commit to everyone going home **safe** and **healthy** every day
- We take **personal responsibility** for our actions and results
- We **support** each other to achieve our fullest potential
- We **act responsibly** to support a sustainable future for the **community** and **environment** in which we operate

Appendix C – A Comparison of Quality Experts[xli]

A Comparison of the Quality Experts

	Deming	Juran	Crosby	Garvin	Feigenbaum	Taguchi
Basic Orientation toward Quality	Technical	Process	Motivational	Strategic, academic	Total, systemic	Technical, proactive
What is Quality	Nonfaulty Systems	Fitness for use; freedom from trouble	Conformance to Requirements	Competitive Opportunity	What Customer says it is	Customer's Performance Requirements
Responsible for Quality	Management	Management	Management	Management	Everyone	Engineers
Goal of Quality	Meet/Exceed customer needs; CI	Please customer, CI	CI, zero defects	Pleasing customers, CI	Meet customer needs, CI	CI, Meet customer requirements
Methods for achieving Quality (1)	Statistical	Planning, control, improvement	14-point framework	Identifying quality niches	Total Quality Control (TQC)	Robust design of processes
Chief elements of implementation (2)	14-point program	Breakthru projects, quality council quality teams	14-point program; COQ mgmt maturity grid	8 dimensions of quality	Statistical and engineering methods across the company	Statistical design of experiments, quality teams
Role of Training	VI for managers and workers	VI for managers and employees	VI for managers and employees	Important but not clearly defined	VI for managers and supervisors	Important but not defined
Weaknesses	Many sit and wait for management to create perfect environment	when special projects done, people simply go back to old job and habits	depends on local quality guru, many people sit tight and wait for the expert			limited audience of engineers and scientists, complex tools

IPM Approaches emphasized by Roger Slater in Integrated Process Management with the addition of the following

(1) Focus on key process inputs and standards

(2) 6-step process with closed loops

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